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"Helicopter Neutralization ---
Performance Testing Protective Forces"

Introduction

Many high risk facilities share a common threat of security incidents being perpetrated by adversaries utilizing rotary-winged aircraft. While the low numbers of actual helicopter-assisted security incidents worldwide suggest that such threats remain rare, the fact that they have occurred offers the obvious conclusion that they are indeed possible. In certain instances the consequences of a successful aircraft-assisted assault (in terms of danger to the public, national security, political damage and/or economic ramifications) are potentially serious enough that extraordinary measures may be justified to prevent such assaults from being successful. Examples might include raids targeting nuclear weapons facilities; military special/chemical munitions depots and naval magazines; or industrial facilities which are of strategic importance to the government of the country in which they are located. While no US Department of Energy or Department of Defense facilities to date have been targeted by adversaries attacking in helicopters, both US federal and state penitentiaries have experienced attempts to free inmates by confederates who have utilized or commandeered civil aviation helicopters. While escaping prisoners may not offer the same threat to the general public as the theft of plutonium or quantities of dangerous chemicals, seemingly innocuous facilities may offer threats beyond those initially recognized. For example, a high profile security incident perpetrated by animal rights activists against a facility utilizing animals to test pathogens or research cures for extremely virulent Eboli or Smallpox viruses may have far reaching consequences.

In most cases the range of potential adversary threats faced by these facilities is not changed significantly by the addition of helicopters. The use of helicopters by adversaries, however, can substantially reduce response times available to site protective forces. Because of the timeline advantages that helicopters offer to adversaries, it may be prudent to investigate the capability for helicopter denial demonstrated by your protective force as part of your annual sitewide security review.

This paper describes the development of performance testing which examined the ability of security forces to detect and neutralize helicopter threats. It describes the application of laser engagement simulation technology to provide data regarding protective force effectiveness. Guidelines and lessons-learned are presented which offer a means of replicating such testing at other facilities which may face helicopter threats.

Helicopter performance testing seeks to measure the relative capability of a protective force to deny adversary target access or escape by helicopter. Test outcomes express protective force capability to neutralize aircraft as ratios of "hits achieved relative to shots available", over time -- e.g. the findings are statistical values. These values thereafter may also be used in computer modeling processes.

While recognizing that Security Policy - e.g. 'identifying that point at which aircraft demonstrate "hostility" and may be engaged' - is also of critical importance, performance testing as described in this paper does not examine protective force actions in response to policy. Our focus examined *only* the tactical ability of the protective force to detect inbound aircraft and achieve a 90% probability of helicopter neutralization; and the technological means with which this might be measured.

PART I -- ESTABLISHING TEST DESIGN PARAMETERS

Threat Characterization

In most cases the first step when examining helicopter neutralization is to define which threats the site is defending against. The primary purpose of identifying which helicopter threats your site is defending against is to determine the probable duration and locations of aircraft exposure.

Helicopters possess certain operational requirements, which in many cases will point to certain "paths" to the target being more likely than others to be utilized by adversaries. Some of these include landing zone size requirements; wind and weather constraints; obstacles, wires, and other obstructions along an approach path; darkness and a need for ambient light at night in the vicinity of the objective; difficulty hovering over sand, dust, snow, and other environments which obscure visibility; and in some cases, short time on station - or time and range constraints based on the total weight they carry in terms of adversaries, the target being sought (if any), and fuel on board.

Different helicopters offer various performance capabilities, in terms of speed, rotor noise, and load capacity. Many potential environmental challenges can be overcome using technology - for example, attacking with helicopters at night by flying at nape-of-the-earth altitudes utilizing night vision goggles. Most aircraft performance characteristics are static, however: a given helicopter will only fly so far at top speed, and will only carry a maximum weight. This will limit and may help define adversary capabilities.

A survey of civil aviation helicopters for lease in your area will provide a range of aircraft performance characteristics which will assist in defining the "most plausible aircraft threat" you must protect against, based on aircraft availability and terrain/physical circumstances at or in the vicinity of your specific facility. [We made an assumption that adversaries are more likely to use an unarmed (i.e. non-weapons platform) civil aviation aircraft. This may not be the case worldwide.] Helicopters primarily provide a more rapid means of ingress or egress. All other attack actions in the objective area remain the same. Once on the ground, adversaries (and/or insiders) must defeat the same barriers and security measures to access the target that they would encounter without the use of a helicopter. Therefore, *in general*, your "worst case scenario(s)" as they are defined *without* the helicopter threat remain(s) your worst case scenario(s) *with* the helicopter threat, and for the same reasons - <u>they still offer the shortest path to the target(s)</u>. The addition of an aerial ingress/egress capability merely reduces response times available to protective force personnel.

There are several fundamental scenarios to be considered in planning helicopter interdiction tactics by protective force personnel; and subsequent testing of response behaviors. Specifically, helicopter-borne adversaries are most likely to do *one or more* of the following:

1) Pick up and escape with a target prestaged by insider(s) or other adversaries - i.e. no landing is required, but a brief hover may be required to attach target to a hoist (where it becomes an internal or external load);

2) Extract personnel/team - which requires a landing or hovering at a "near landing", while adversaries w/w/o target(s) run to the aircraft or secure themselves to rigging beneath the aircraft; and/or

3) Attack or provide diversions, etc. - adversaries may, for example, arrive via helicopter; deploy chemical agents, incendiaries, smoke, or conduct similar hostile actions from a helicopter, either individually or in support of other attacking elements on the ground.

As noted, the primary purpose of identifying which helicopter threats the site is defending against is to define the probable duration and locations of aircraft exposure during the adversary attack. Average attack exposure times might be, for example, 30 seconds to hover while loading; 20 seconds to load or unload personnel; and 10 seconds to ingress & flare/another 10 seconds to egress. Initially establishing a set of assumptions regarding aircraft exposure times is essential for test design. These assumptions can always be modified later, however, they are foundational for all follow-on tactical response planning; that is, they determine the length of time a protective force officer might have to acquire and engage the aircraft target. Hence, performance testing may determine the probable success provided by such planning. Often, aircraft exposure times may be derived using a variety of computer modeling programs and/or data provided by subject matter experts/consultants. Regardless of the source, it is necessary to determine which exposure times will be used before helicopter testing can be developed. Documenting how and on what basis these helicopter exposure times are established is critical. In order to obtain valid results the threat parameters must first be carefully defined.

<u>Describe your current protection strategy against helicopter threats</u>

The second set of performance test parameters which need to be defined are the protective force emergency response plans - the distances and angles at which attackers might be engaged with small arms; the number of shooters which logically might be expected to bring the aircraft under fire (within estimated time available); and other considerations which might impact either adversary or protective force behavior.

The tests we are describing cannot examine protective policies or defense strategies directly. Instead, the tests will allow determination to be made that - if the adversaries are exposed for a specific time; and if the protective force is able to bring X fire to bear on the adversaries during this time; then (a correlation against 'known values' suggests) there is a Y% probability that the adversary aircraft will be neutralized.

In turn, such values will allow computer modeling to take place which will indicate whether a protection strategy is likely to be successful, or the degree to which your strategy tends towards success or failure. Computer modeling also may provide other options. For example, using the assumed aircraft exposure times; modeling may suggest other response actions that are possible within the time limits available to protective force personnel. In reviewing your initial site protective strategy against aerial threats, consider factors such as:

- Your facility's physical qualities -- the presence of static barriers (e.g. fences, doors), natural terrain features, or other design characteristics which channel adversary movement or provide a tactical advantage to the protective force;

- Strategic response locations -- routes to these locations, likely target locations (in the air over rooftops, parking lots, etc.), obstructions to small arms fire against helicopters, and potential initial locations of responders at the moment of a random aerial attack;

- External resources -- military or police air assets, local radio station aircraft, local airports, etc. which might immediately provide visual assistance, radar tracking, or other response capabilities, etc.;

- Other factors -- terrain in the vicinity of the site, prevailing winds and weather patterns, glare lighting, etc.

The goal is to determine the probable number and locations of shooters able to bring fire to bear on adversary aircraft during an attack within the time durations identified. In addition to identifying test parameters (i.e. distances at which test aircraft will be engaged), this number also provides equipment and logistical requirements (i.e. MILES weapons, vehicles, radios, etc.) and personnel requirements, both Shooters/ Participants as well as Controllers, to support performance testing.

Create a written Statement of Test Purpose

A written statement defining the purpose of the performance test can be as simple as, for example, "...to determine whether or not current protective force resources are adequate to neutralize identified security threats". As with establishing the assumptions regarding threat parameters, it is critical to later determining the degree to which the test was successful, and the validity of the results; to define *specifically what we want to accomplish and how we intend to accomplish it.*

A written statement of the test purpose is crucial later when evaluating results because it provides a previously agreed upon standard or criteria against which to measure "what did we accomplish?"; or "to what degree were we successful - did we ultimately test what we wanted to test?". This in turn provides confidence that the results are either valid or are not valid, based on the degree to which they allow us to measure desired behaviors and/or outcomes.

The point is that post-test success or failure will be measured against previously identified purposes for the testing. In order to be "successful", then, the goals of testing must be rigorously constrained and defined. In the likely event that testing has not been done before, then no "pass" or "fail" should be determined. The goal initially is to simply establish a data baseline against which future test results can be compared.

PART II -- DEFINING LOGISTICS REQUIREMENTS

Identify sources for helicopter support services

Helicopter availability to meet your test requirements will, to a large extent, govern dates and times available for testing. Helicopter operations, as well as MILES weapons operation, are constrained by weather conditions. Otherwise, generally helicopter leasing companies will be able to meet your needs, but they must understand clearly what you want them to do. If your facility processes classified information or handles hazardous materials, classification issues may impact on your ability to communicate your needs to the commercial helicopter company. In this case, you should involve your Classification Office early in the process to avoid compromising classified information.

For the most part, commercial providers of helicopter services are willing to provide testing support, however, some may be able to do so with greater ability than others. We contracted with a company which provides both aerial camera platforms and stunt helicopters to the movie industry. Their pilots were used to hovering over buildings and moving vehicles, flight at unusual attitudes and maneuvers, being shot at with a variety of small arms or missiles, special effects, etc.

You must estimate the number of flight hours you need - i.e. hours in the air, not including hours on the ground getting personnel into position, etc. Demands for on-station airtime will drive fuel consumption and frequency of refueling stops, as will need to carry adversaries, targets, and other activities. You must be able to discuss in detail your requirements with the helicopter contractor in order to allow the contractor to plan for personnel, fuel and aircraft hours, however, as mentioned above, classification concerns must first be resolved. In particular, the attachment of MILES sensor harnesses to the exterior of the aircraft must be carefully understood by all parties. Care must be taken to provide for safety under all circumstances.

Pilots must be briefed that protective force personnel will be firing MILES weapons at the helicopter. Aircrew concerns must be discussed. Pilots should plan to be present at all pre-exercise briefings and observe procedures whereby participants are cleared of all live ammunition and weapons prior to MILES laser weapons and blank ammunition being distributed. You must provide weight estimates to the pilot for MILES harness & system controller/buffer, computer(s), technician and Helicopter Controller, videocameras, and other equipment needed in the aircraft. You may also want the pilot to wear a MILES harness, depending on the type of helicopter used.

A number of helicopter logistics requirements must be arranged among facility contractors or departments, and a team approach is suggested as the most efficient means of facilitating widespread communication and coordination. The following are basic requirements, others will be discovered throughout the planning process:

- A landing pad must be arranged, if none exists, and must be swept of gravel, dust, and small objects before the helicopter uses the pad.

- An emergency landing zone must be identified, such as a large open parking lot, lawn, or open area. It must also be examined for obstructions, trash, or small objects that could become airborne in rotor wash or could be sucked into engine air intakes.

- Write a Flight Safety Plan. Consult FAA regulations for flight in and around your facility. Your plan should be approved by safety engineers, in concert with building managers, shift supervisors, etc. What restrictions on aerial activity exist? Minimum altitudes? Environmental restrictions on flight? Site restrictions on flight (i.e. not over reactors)?

- Building managers and personnel must be notified if aerial activity is to take place over any building on your facility. Efforts should be made to schedule the test on a weekend, so that parking lots are clear and non-participant personnel in the area are minimized.

- Determine a safe location to conduct refueling of the aircraft. In many cases, the contractor will have a fuel truck they can position near the landing pad to facilitate quick refueling. This is invaluable during testing. Investigate fire department availability for hot refuel assistance/safety.

- Identify a location for the helicopter to report to in the event a real alarm or incident occurs during the test. This may be a small orbit above a predesignated ground location, to avoid delays if the interruption is not lengthy, or may mean landing at a local airfield or the primary landing pad to avoid incurring additional costs if the interruption is longer.

- Research availability of commercial airport services (tower, airspace control, refueling, emergency landing, etc.). Notify any local airport tower control of testing the day before. Are there radar and weather support services nearby which can quickly be contacted?

<u>Identify sources for ESS/MILES weapons and equipment</u>

Engagement Simulations System (ESS) or Advanced Multiple Integrated Laser Engagement System (MILES) equipment has been used by the military for over twenty years to simulate armed conflict between opposing forces. It is available through a variety of federal sources to government entities. It may also be available through a number of manufacturers to non-government entities, for either lease or purchase.

For the purposes of this paper, it will be assumed that readers are familiar with ESS/MILES laser weapons and equipment and the parameters concerning its use within the performance testing environment. A complete technical and operational discussion of the laser weapons and equipment is beyond the scope of this paper. Even assuming readers are familiar with ESS/MILES equipment, and may have used it in force on force exercises previously, readers must understand that such equipment is used much differently for gathering statistical data during helicopter neutralization performance testing than during standard force on force exercises.

It is important that you understand that, for the purposes of helicopter threat interdiction performance testing, there are significant technological differences between what is required of standard helicopter ESS/MILES equipment used during force against force exercises and requirements for ESS/MILES equipment needed to test helicopter neutralization. Equipment designed and set up for force on force exercises will NOT adequately support data gathering to measure anti-aircraft capabilities. ESS/MILES equipment is used during force on force exercises to determine whether ground-based small arms fire has "killed" or taken the aircraft out of play. Thus, the harness counts a random number of hits, often determined by a random number generator or preset before the exercise, and then activates - "killing" the helicopter.

This is counterproductive to the requirements of helicopter denial performance testing. During helicopter neutralization tests, the objective is to count the number of times the aircraft sustains hits from ground-based small arms fire over time. For example, results should indicate that within the first 10 seconds the helicopter was hit X number of times; within the second 10 seconds the helicopter was hit Y times; and within the third 10 seconds was hit Z times. This will yield a total number of hits over the total of 30 seconds, as well as hits per intervening intervals. To yield output of greater value, moreover, software should be utilized that tracks which specific laser weapon struck the sensors at which time, and in which chronological order. Advanced MILES weapons laser emitters are individually coded, and codes should be assigned to specific shooters/locations. Software times should also be correlated to exercise times - i.e. real time; so that ground actions/shooter locations may be judged in terms of one action or location being more valuable or efficient than another.

All data regarding MILES system performance should be capable of being recorded in a MILES system buffer, for downloading into a computer, either later or - ideally - as it occurs or "real-time". Analysis of data printouts will allow determination to be made of which firing position(s) produced the greatest number of hits, and total numbers of hits from specific weapons received over incremental aircraft exposure times. This type of data will also allow statistical conclusions to be reached regarding different probabilities of helicopter disablement under real world conditions.

We utilized an Advanced MILES system manufactured by Schwartz-Electro Optics (SEO), of Orlando, Florida. Known as the "Multiple Integrated Target System" or MITS, we understood that it would perform so as to meet our needs. Data stored in the buffer of the MITS system may be later downloaded into a computer hard drive.

The system provided a great deal of data, however, due to the differences between ordinary force on force exercise requirements and our requirements, it did not provide all the data we required. SEO technicians are currently exploring the potential for the system to be redesigned to more specifically meet our purposes.

One of the most important lessons learned during our helicopter performance testing was that the ESS/MILES gear must be carefully installed and must be functioning perfectly in order to gather all data and yield optimum results. Lack of sensors on the exterior of the aircraft; system delays in counting the number of hits received by the sensors, especially when multiple hits strike the sensor harness simultaneously; the inability of the system buffer to hold large numbers of hits; and system delays as the harness resets itself after "activating" (i.e. killing the helicopter); all negatively impact the validity of the data collected. [The data you recorded may be valid, however, questions remain regarding that amount of data you failed to record, and the relative percentages of data recorded to data lost.]

As a result of our experience it is recommended that you consider running your entire performance test first on the ground, on a preliminary basis, using a vehicle set up with the helicopter MILES harness, with all participants/shooters firing at the vehicle. This type of pretest run before the actual performance test is conducted with helicopters will provide cost-efficient experience to all participants and controllers, and offers a chance to ensure MILES equipment is working properly - providing a better chance at recording vital data later. Moreover, it provides experience to shooters at engaging targets moving at speeds of 30 to 40 miles per hour using MILES weapons (laser weapon ballistics are different from standard ammunition ballistics).

Another important lesson learned is that it is vital to have a technician from the manufacturer accompany the ESS/MILES equipment utilized. Equipment failures can have significant impacts on test success, and given the cost and coordination required to run the test, failures must be corrected rapidly (to the best of the technician's ability) so that the test is not cancelled. This requires skilled technical support.

Other lessons learned during Advanced MILES helicopter neutralization performance testing include:

- Ensure there are adequate sensors on outside of aircraft to record multiple simultaneous hits. In some cases, the MITS system buffer will only handle so many hits at once, in which case multiple buffers may be necessary, each with their own sensor harness. An alternative is to redesign system hardware to meet your specific requirements.

- Be aware of locations of sensors on aircraft relative to shooter locations on the ground. We utilized safety requirements that aircraft maintain 100' above ground level (AGL) - i.e. at times shooters were shooting UP at the bottom of the aircraft. MITS/Advanced MILES sensors were installed on step rails above aircraft skids on both sides of the fuselage, therefore, no hits aimed at the bottom of the aircraft would register on the sensors.

For any laser hit to be recorded, the angle of the laser beam to the sensor plane must be between 90° and 45°. Shots striking at an angle of less than 45° will not register on the sensor. Both vertical and horizontal sensor angles are impacted by this condition. Because no sensors were installed on the bottom of the helicopter, the laser to (side) sensor angle from distances approaching 50 yards for some shooters may have rendered many of their hits invalid. No sensors were installed on the front or back of the aircraft. Laser/shooter to (side) sensor angles for approaching and departing helicopters may have resulted in many shots which might have hit the aircraft under real-world conditions not being recorded by the MILES harness.

- Clarify requirements with the MILES manufacturer for data storage, retrieval, print-out for analysis, etc. This is critical to measuring results and outcomes. Be specific with the equipment manufacturer, in writing, as to what you expect the system to produce during the course of the performance testing. Examples include requirements such as:
    a) "we need the equipment to count the total number of hits received, over the number of seconds that the aircraft is exposed to fire";
    b) "we need a sufficient number of sensors and buffers so that all hits on aircraft vulnerable areas can be recorded";
    c) "we need all event times to be correlated to real-time";
    d) "we need individual weapons coded for later analysis as to which firing positions afforded the greatest number of hits, etc";
    e) "we need all data recorded to be printed out for analysis".

- Each time the MITS harness receives/records a hit, it shuts down for 1 second. No other hits can be recorded during this period, although the manufacturer indicates that by reducing the amount of coded data contained in each laser burst, this reset time may be significantly reduced (but not eliminated).

- Whenever the helicopter harness "activates", or indicates a kill, it shuts down and must reset - which requires a minimum of 4 seconds. After the system goes off and before it resets, no hits striking the harness will be recorded. [Ideally, helicopter sensor harnesses should not activate at all, but should simply count the number of times they are hit and by which laser transmitter.]

- Only one hit on a sensor harness at a time will be recorded. If two or more hits strike the harness simultaneously, only the first of these will be recorded. Computer printouts may indicate several coded weapons, indicating that multiple hits were being received, however, only one hit will be recorded - no count of all hits simultaneously striking the harness is possible.

- We used only two strips of 3 sensors each, instead of four strips. Only 5 sensors were available to be hit by ground fire. Even with so few sensors, the volume of fire received overwhelmed the system's ability to record hits. Even had we installed the other two sensor strings, and had shooter fire been

accurate in striking these other sensors, no other hits could have been recorded by the control unit buffer - as it was already overwhelmed by the volume of fire striking the 5 sensors available. In the future, hardware redesign should reduce many of these concerns, however test plans must also be redesigned to accommodate the limitations of the equipment.

- The system was not designed to record heavy concentrated volumes of fire. The MITS buffer will only hold approximately 360 hits. Thereafter, until it has been downloaded, no further hits will be recorded. Hardware may be altered so as to raise buffer limits.

- Recorded events/data times were not correlated to real-world time. Each time the system reset, all system times were zeroed out again. System resets occurred frequently, due to operating the system beyond its designed parameters. Accordingly, printouts reveal numerous instances in which test times were zeroed out, resulting in a series of random time intervals. None of these intervals could be matched to specific times or event during the test; thus no correlation of "X hits received during 20 seconds", etc. could be derived.

- Be aware that additional ground-based testing may be required to substantiate Advanced MILES/MITS findings. For example, for protective force personnel equipped with fully automatic or "burst-capable" weapons, the laser transmitter will only emit 'one laser pulse per trigger pull'. The first blank round actuates the laser pulse. Only one pulse will be transmitted, regardless of how many blanks are fired. Therefore, the aircraft harness will only register one hit, assuming the pulse strikes it.

  This suggests that, if multiple projectiles are fired in short bursts by protective force personnel; in order to obtain credit for multiple hits on the aircraft, additional testing must be performed on the live fire range to document the capability of shooters to hit aircraft-sized targets at various ranges with multiple projectiles fired in short bursts. Thereafter, a 'force multiplier' value may be applied to total harness hits which will account for multiple projectiles striking the aircraft with each single laser pulse recorded.

We were using the Advanced MILES system beyond its designed operating parameters. The lesson is that tests must be designed to take the limitations of technology into consideration, and technological design limitations must be well understood, to acquire optimal data. Currently, it remains unknown whether any off-the-shelf technology exists, to allow this specific type of anti-aircraft testing to continue. SEO is currently examining both hardware and software to design a more responsive MITS helicopter neutralization testing system.

<u>Global Positioning System (GPS) equipment and software</u>

Standard civilian GPS units were used to identify helicopter locations and distances from site when the aircraft was initially spotted. First, initial locations of protective

force posts were entered into the units. During testing, as the aircraft approached the facility, aircraft locations when the protective force first reported the aircraft inbound were also programmed into the GPS devices. Distances were then calculated by the GPS units between the location at which the aircraft was spotted, and the location of the post which spotted it. This information was downloaded from the GPS units themselves into computers, and commercially available software was then used to generate maps illustrating the relative protective force positions and aircraft locations as each test attack took place. The period between the time at which the aircraft was spotted and the time it arrived over the target area was recorded using stopwatches. These approximate intervals could be used to estimate reaction times available to protective force personnel.

Over time, and with repetition, such data yields graphic representations of likely helicopter avenues of approach; probable locations where it would likely be spotted; and approximate response times available to protective force personnel in which to react. You may discover that at your facilities, some of your resulting reaction times may be less than expected, which may impact on your tactical response and weapons or equipment planning. The following steps were taken to establish this capability with commercially available Global Positioning System hardware and software:

1) Survey GPS equipment available currently; features which facilitate data gathering; and related computer software which allows linkage with GPS units, data downloading, and subsequent analysis; and

2) Practice downloading coordinates acquired during pre-testing into software, and using software to generate maps, distances, etc.

<u>Camera's: Documentation with Video and Still Photography</u>

Photographs and videotape documentation provide a significantly greater, more in-depth explanative ability for clarification of problems encountered; test circumstances and environmental influences; and foundations for analysis and post-test problem-solving. We used one videocamera and one still digital camera to record data and to document test conditions. Both provided a vital sense of test conditions, difficulties encountered on the firing line, and angles of visual observation and fields of fire. More may be used, depending on your individual circumstances. During the data analysis phase, still digital photos were scanned into a computer and printed with a color printer, so that images could be imported into final reports provided to management.

<u>Personnel</u>

Pre-test training is of tremendous importance. This does not refer to job oriented training, which should already be accomplished, but to pretraining for running helicopter detection and neutralization performance testing. Consider the following:

- Shooters should receive instruction in MILES equipment stoppages and weapons failure drills, which may occur more often than encountered when

firing standard weapons. This is critical for achieving maximum MILES hits on the helicopter within very short time durations.

- Two shooting relays were used so that one relay could be reloading while the other was firing, thus reducing aircraft downtime. Controllers should receive training regarding shooting line safety and the manner in which shooting relays are to be moved from location to location during the tests. A dry run or pre-test using a vehicle would be of value to rehearse both participants and controllers.

- Videocamera Operators and Photographers should receive instruction regarding camera angles sought to document helicopter engagements. In particular, documentation showing shooter positions and views of the helicopter from each shooter's location are useful during later analysis.

<u>Pre Test Planning</u>

A team approach was used to ensure cross departmental communications and coordination. "Punch-List meetings" were held twice weekly, at which all logistics coordination planning efforts were tracked, problems identified and responsible parties identified to resolve issues. At each meeting, events were systematically confirmed as completed and the integration of future support efforts was planned. These meetings proved critical to the success of the overall endeavor. Several items were specifically discovered to be especially important.

In particular, administrative procedures must be approved for passing out/retrieving MILES weapons and ammunition, and ensuring separation of live ammunition/weapons from MILES ammunition/weapons; if such procedures are not already in place.

A comprehensive understanding of the overall intent must be well communicated. In our helicopter neutralization performance testing we initially sought to establish average baseline "hit ratios" for individual shooters, firing at a helicopter from known distances, for predetermined exposure times. This information was general enough that it could later be input into different computer modeling software and applied to multiple scenarios. Ensuring this was well understood by all personnel paid off later, when Controllers reported numbers of rounds *unfired* from malfunctioning magazines and other essential data which had not previously been considered.

Rangefinders and orange cones were used to mark the individual firing positions and known distance "firing lines" used to establish statistical probability of hits at various distances (from each helicopter "target"). We discovered that a central firing line controller, located in an elevated position and equipped with a bullhorn, was extremely useful to control the widely distributed firing lines. Firing lines were established at 50, 100 and 200 yard distances from helicopter targets. Only one firing line was active at a time, beginning with the 50 yard line. Shooters stationed along each firing line were divided into two relays - port and starboard - so that half the shooters were firing while the other half were reloading.

As each shooter began each iteration of the test with a full duty load of ammunition, this meant that each shooter generally fired a full duty load during each iteration, and had to reload in between each iteration. Time constraints dictated that 2 relays per firing line were the most efficient use of helicopter flight time. Each relay at each firing line engaged the helicopter three times, to achieve a statistical average of hits at each line. Each firing line was thus run six times, three times for each relay.

Arrangements must be coordinated for logistics support during testing. Helicopter time is expensive, and there is a need to be able to solve problems encountered during testing rapidly so as make efficient use of the aircraft. In particular, a tremendous amount of blank ammunition will be fired by shooters. MILES weapons and magazine failures should be expected, and preparations made to replace weapons and magazines as they fail, or clean or repair them. Attention must be paid to details. Armorers should be available with spare weapons, tools and lubricants.

Written permission should be obtained from building managers over whose buildings the aircraft will be hovering, due to potential impact on air conditioning systems, communications equipment, and other rooftop mounted building control systems.

<u>Emergency Responder Notifications</u>

Aside from the notifications made administratively to impacted organizations, management, and surrounding authorities; identify those agencies and resources you would need to communicate with in the event that any real-world emergency should take place while testing is being conducted. A minimum list of such "mutual aid" responders might include examples such as:

- Medical Response (ambulance);
- Fire Department;
- Local Law Enforcement Agencies;
- Electrical Utilities, Mutual Aid Resources, etc.;
- Tower Control at Local Airfields;

In particular, arrangements should be made to have fire apparatus standing by when the helicopter lands, and during all hot refueling operations. This allows the helicopter to rapidly be refueled on the landing pad in between performance test iterations.

PART III -- CONDUCT OF TESTING

<u>Establishment of Flight Safety Parameters</u>

Flight safety parameters include both primary and emergency landing pads, possibly temporarily arranging for use of a large parking lot; and a helicopter landing zone for in-flight emergencies. These areas must be swept for debris or "foreign objects on the deck" ("FOD"), and carefully examined for obstructions or environmental factors such as blowing dust, snow, etc.

Flight safety plans must be reviewed by Safety Departments, must identify all high obstructions in and around your facility, and should conform to all safe FAA standards. In particular, Flight Safety Plans must be gone over in detail with the helicopter leasing company and the pilot, so that all personnel involved are aware of safety considerations.

Laying Out and Controlling Firing Lines and Shooting Positions

Individual shooting positions and general line configurations must be established the day before the performance test, after the parking lots have emptied out. Establish the location of the Central Line Controller at center of firing lines, equipped with a bullhorn and radio to call cease-fires as needed, to best control movement of test participants on the ground. The Central Line Controller must also be in contact with the Helicopter controller. Controllers with at individual shooter positions or vehicles containing two shooters will control staged firing and movement, ammunition reloading, problems related to MILES weapons, location of photographers relative to shooters, etc. Ensure that arrangements are made to collect all spent brass at the conclusion of the exercise. Ensure the Armorer is stationed in the vicinity of the firing lines, where shooters can take MILES weapons for lubrication, brief cleaning, etc.

Contingency Plans for Actual Emergencies

Contingency Plans must be established and reviewed by all Controllers for execution as needed during the limited scope performance test. Contingency Plans include, but are not limited to, such interruptions as:

- Actual Alarms and Incidents, and subsequent activation of actual (non-test participant) protective force personnel in response to the Alarms;
- Weather Interruptions;
- Illness (during our testing one shooter had to withdraw from the firing line due to illness);
- Non-reparable Equipment Malfunctions;

In particular, if protective force personnel are utilized as performance test shooters and are armed with MILES weapons; specific and detailed contingency plans must be prepared and briefed which set forth the manner in which -- during response to an actual alarm occurring during the performance test -- MILES-armed shooters and Controllers will cease all activity while the "Shadow Force" (actual protective force personnel armed with real weapons) responds to the incident and/or clears the alarm.

PART IV -- ANALYSIS OF FINDINGS

Data Collection Sheets

Data collection packets were distributed to Controllers during the pre-exercise briefings. They contain forms that Controllers are to fill out regarding data the Analysts need to corroborate MILES buffer printouts, GPS data, and stopwatch

response times from the helicopter controller. At the conclusion of the exercise, the Senior Controller must collect all data collection packets from all Controllers. These must be locked up together with any computer print-outs; videotapes; photographs; and any other identification of test results. Your raw data may require classification.

Data should be reviewed by a team of analysts who will establish preliminary findings and outcomes from all raw data. The goal is to arrange hits over time in matrices which set forth the relationship between aircraft exposure time and the probable number of hits sustained by the aircraft during different exposure times; as well as which shooter locations afforded - in general - the most favorable conditions under which to engage the aircraft. In our case, outcomes included both total hits received by the system at varying ranges and exposure times, as well as findings regarding shooter location efficiency and other ideas for enhanced training. Additionally, aircraft GPS locations and distances should be examined to refine any anticipated aircraft ingress/egress routes, and potential actions to be taken in response to findings.

Correlation of Findings

Data regarding number of hits over time and probable neutralization outcomes, should be correlated using known statistical performance parameters. Information may be found in both US government and private references providing baseline helicopter neutralization data. We utilized baseline data taken from a classified report produced by the US Army's Piccatinny Arsenal (Rahe & Chu 1997), and from Gene Greneker (1991) of Georgia Tech Research Institute. Beware of bias injected during performance test design, which may influence both data gathering as well as findings.

Application of Results/Findings to Current Protection Strategy

Results should be analyzed with your protection strategy against helicopter threats, as defined during your initial performance test planning stage. Subsequent computer modeling using this data should provide at least preliminary indications that the strategy is either possible, or is not possible given current resources and plans. Remember that all findings are essentially baseline, and that results should be corroborated by additional testing prior to significant changes being implemented. Alterations to site protection strategy, emergency response plans, training, shooter positions, etc. should be contemplated as part of an integrated response planning function.

Outcomes Analysis -- "What does it all mean"?

Remember that different individuals may review the data and arrive at different conclusions. You may experience a situation where someone attempts to take your findings and apply them to a slightly different set of circumstances. This can be misleading. This is the point at which test results must be carefully scrutinized in view of the initial purpose and goals of the test; and outcomes must be strictly constrained by those parameters established early in the process. Just because X number of hits were sustained by a helicopter hovering for Y seconds, for example, it cannot be

extrapolated that Z number of adversaries jumping from that helicopter would sustain any measurable reduction in offensive capability. All performance test outcomes must be strictly interpreted in light *only* of the original test conditions.

The data resulting from the test must be analyzed only against the pre-identified standards and criteria for Protective Force behaviors. Findings must be compared only against previously declared intentions. Questions regarding the validity of the data already exist due to artificialities invariably introduced during the performance testing process. It would be unhelpful to attempt to 'what if' the outcomes, and draw conclusions regarding other, more broad scenarios from the data derived from very constrained scenarios.

Your analysis seeks to confirm the answer to the question "did we ultimately wind up testing what we wanted to test"? This requires a careful review of findings against the initial statement of assumptions; as well as subject matter expertise, good judgement, and common sense.

Recommendations

It is the responsibility of the team of analysts to draw logical conclusions from the test findings and outcomes. They seek to answer the question: "Where do we go from here"? They seek also to recommend different options for the protective force and security management to enhance the facility strategic planning against helicopter threats. Be careful with your recommendations!

It is important to avoid pitfalls while drawing conclusions from data derived through highly-constrained test parameters. Many pitfalls involve assumptions that the results of the performance test truly represent reality; i.e. that the results are valid. It is important to remember that *any initial results take the form of unproven hypotheses,* and require additional performance testing before they can either be confirmed or be dismissed as misleading.

SUMMARY

This paper described lessons learned during the design and development of performance testing which examined the ability of security forces to detect and neutralize helicopter-borne adversary threats. We have reviewed the significant definition of goals and coordination required to conduct such testing, as well as the difficulties involved with attempting to derive meaningful results from tests conducted under obviously artificial environmental conditions and numerous safety constraints. For additional information please contact:

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